

THE INVENTION CLAIMED IS:

1. A method of hierarchical scheduling
comprising:

receiving data from one or more pipes, each
5 pipe including a plurality of pipe flows;
selecting a winning pipe from the one or
more pipes from which to transmit data based upon one or
more quality of service parameters corresponding to the
winning pipe;
10 selecting a pipe flow from the plurality of
pipe flows included in the winning pipe based upon one or
more quality of service parameters corresponding to the
selected pipe flow; and
transmitting data from the selected pipe
15 flow.

2. The method of claim 1 wherein transmitting
data from the selected pipe flow includes transmitting data
from the selected pipe flow using a bandwidth corresponding
20 to the winning pipe flow.

3. The method of claim 1 wherein selecting a
winning pipe from the one or more pipes from which to
transmit data based upon one or more quality of service
25 parameters corresponding to the winning pipe includes
writing data identifying a pipe to a memory address in a
group of memory addresses based upon one or more quality of
service parameters corresponding to the pipe and scanning
the group of memory addresses to find data identifying a
30 pipe.

4. The method of claim 3 further comprising
rewriting data identifying the winning pipe to a memory
address in a group of memory addresses based upon one or
more quality of service parameters corresponding to the
5 winning pipe.

5. The method of claim 1 wherein selecting a
pipe flow from the plurality of pipe flows included in the
winning pipe, based upon one or more quality of service
10 parameters corresponding to the selected pipe flow,
includes:

writing data identifying a pipe flow to a
memory address in a group of memory addresses based upon
one or more quality of service parameters corresponding to
15 the pipe flow;

scanning the group of memory addresses to
find data identifying a pipe flow;

writing the identified pipe flow in a queue
corresponding to the winning pipe based upon one or more
20 quality of service parameters corresponding to the selected
pipe flow; and

selecting the identified pipe flow from the
queue corresponding to the winning pipe.

25 6. The method of claim 5 further comprising
writing data identifying the selected pipe flow to a memory
address in a group of memory addresses, based upon one or
more quality of service parameters corresponding to the
selected pipe flow.

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7. A method for hierarchical scheduling
comprising:

receiving data identifying a pipe flow, the
pipe flow included in a pipe;

writing data regarding the pipe to a first
calendar;

5 writing data regarding the pipe flow to a
second calendar;

scanning the first calendar for a winning
pipe;

10 scanning the second calendar for a winning
pipe flow;

writing the winning pipe flow to a
corresponding pipe queue;

using the winning pipe to select a pipe flow
from a corresponding pipe queue; and

15 transmitting data from the selected pipe
flow.

8. The method of claim 7 further comprising
rewriting data regarding the winning pipe flow to the
20 second calendar.

9. The method of claim 7 further comprising
rewriting data regarding the winning pipe to the first
calendar.

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10. A network processor comprising:

at least one memory adapted to store one or more
quality of service parameters corresponding to one or more
pipes and pipe flows; and

30 scheduler logic, coupled to the at least one
memory, adapted to:

receive data from one or more pipes, each pipe including a plurality of pipe flows;

select a winning pipe from the one or more pipes from which to transmit data based upon one or more
 5 quality of service parameters corresponding to the winning pipe;

select a pipe flow from the plurality of pipe flows included in the winning pipe based upon one or more quality of service parameters corresponding to the
 10 selected pipe flow; and

transmit data from the selected pipe flow.

11. The network processor of claim 10 wherein the scheduler logic comprises:

15 a primary calendar for storing at least one of an autonomous flows and a pipe that are scheduled to be serviced;

a secondary calendar for storing pipe flows that are scheduled to be serviced; and

20 a pipe queue table for storing a winning pipe flow in a queue for a pipe to which the pipe flow corresponds.

12. The network processor of claim 11 wherein
 25 the scheduler logic further comprises:

enqueue and new attach logic for scheduling at least one of an autonomous flow and a pipe flow to be serviced; and

30 dequeue and reattach logic for selecting at least one of an autonomous flow and a pipe flow to be serviced.

13. The network processor of claim 10 wherein the scheduler logic is further adapted to transmit data from the selected pipe flow using a bandwidth corresponding to the winning pipe flow.

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14. The network processor of claim 10 wherein the scheduler logic is further adapted to write data identifying a pipe to a memory address in a group of memory addresses based upon one or more quality of service
10 parameters corresponding to the pipe and scanning the group of memory addresses to find data identifying a pipe.

15. The network processor of claim 14 wherein the scheduler logic is further adapted to rewrite data
15 identifying the winning pipe to a memory address in a group of memory addresses based upon one or more quality of service parameters corresponding to the winning pipe.

16. The network processor of claim 10 wherein
20 the scheduler logic is further adapted to:
write data identifying a pipe flow to a memory address in a group of memory addresses based upon one or more quality of service parameters corresponding to the pipe flow;

25 scan the group of memory addresses to find data identifying a pipe flow;

write the identified pipe flow in a queue corresponding to the winning pipe based upon one or more quality of service parameters corresponding to the
30 selected pipe flow; and

select the identified pipe flow from the queue corresponding to the winning pipe.

17. The network processor of claim 16 wherein the scheduler logic is further adapted to write data identifying the selected pipe flow to a memory address in a group of memory addresses, based upon one or more quality
 5 of service parameters corresponding to the selected pipe flow.

18. A network processor comprising:
 at least one memory adapted to store one or
 10 more quality of service parameters corresponding to one or more pipes and pipe flows; and
 scheduler logic comprising a first calendar and a second calendar, coupled to the at least one memory and adapted to:
 15 receive data identifying a pipe flow, the pipe flow included in a pipe;
 write data regarding the pipe to the first calendar;
 write data regarding the pipe flow to
 20 the second calendar;
 scan the first calendar for a winning pipe;
 scan the second calendar for a winning pipe flow;
 25 write the winning pipe flow to a corresponding pipe queue;
 use the winning pipe to select a pipe flow from a corresponding pipe queue; and
 transmit data from the selected pipe
 30 flow.

19. The network processor of claim 18 wherein the scheduler logic further comprises:

a pipe queue table for storing a winning pipe flow in a queue for a pipe to which the pipe flow
5 corresponds;

an enqueue and new attach logic for scheduling at least one of an autonomous flow and a pipe flows to be serviced; and

a dequeue and reattach logic for selecting
10 at least one of an autonomous flow and a pipe flow to be serviced.

20. The network processor of claim 18 wherein the scheduler logic is further adapted to rewrite data
15 regarding the winning pipe flow to the second calendar.

21. The network processor of claim 18 wherein the scheduler logic is further adapted to rewrite data regarding the winning pipe to the first calendar.